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Section D

Cost Management concepts



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Section D: Cost Management and Performance Metrics (20%)

Study Unit 32: D.1. Cost Measurement Concepts

Costs Based on Level of Activity (Fixed, Variable and Mixed Costs)

In the following table are the main groups of costs **based on their behavior as the level of activity changes**. An **activity** is an event, task, or unit of work with a specified purpose. "Activity" in production can refer to the number of units of a resource used such as hours of direct labor, or it can refer to the number of units of product produced. Both production costs and period costs can be classified based on activity level, though the type of activity used in the classification of period costs is different from that used for production costs. For period costs, "activity" frequently refers to number of units sold, though it can be used for any type of activity that incurs costs.

For the following three types of costs, candidates need to know both how the cost per unit of activity changes and how the total cost changes as the level of activity changes.

Fixed, Variable, and Mixed Costs

Fixed costs	Fixed costs do not change within the relevant range of activity. As long as the activity level remains within the relevant range, the **total amount of fixed costs does not change** with a change in activity level such as production volume. However, the **cost per unit** decreases as the activity level increases and increases as the activity level decreases.
Variable costs	Variable costs are costs such as material and labor (among production costs) or shipping-out costs (among period costs) that are incurred only when the activity takes place. The **per unit variable cost remains unchanged** as the activity increases or decreases while **total variable cost** increases as the activity level increases and decreases as the activity level decreases. Note: Because discounts are often received when more units are purchased, it may appear that variable costs per unit decrease as activity increases. However, companies do not order units of production inputs one at a time. As part of the budgeting process a company determines how many of a particular input it will need to purchase during the year, and the cost per unit for that quantity of inputs is used in the budget. Therefore, budgeted variable costs per unit do not change as the production levels change for the company.
Mixed costs	Mixed costs have both a fixed and a variable component. An example of a mixed cost is a contract for electricity that includes a basic fixed fee that covers a certain number of kilowatts of usage per month, and usage over that allowance is billed at a specified amount per kilowatt used. The electricity plan has a fixed component and a variable component. A mixed cost could also be an allocation of overhead cost that contains both fixed and variable overheads.

Cost Behavior in the Production Process

Fixed costs, variable costs, and mixed costs behave in fundamentally different ways in the production process as the production level changes. It is important for candidates to understand how total costs and costs per unit change as production changes. Although cost behavior is not inherently difficult, it is such an important underlying element of the production process that it will be discussed in detail.

Variable Costs

Variable costs are incurred only when the company actually produces something. If a company produces no units (sits idle for the entire period), the company will incur no variable costs. Direct material and direct labor are usually variable costs.[80]

1) As the production level increases, **total variable costs will increase**, but the **variable cost per unit will remain unchanged**.
2) As the production level decreases, **total variable costs will decrease**, but the **variable cost per unit will remain unchanged**.

Note: The selling price per unit minus all unit variable costs is equal to the **unit contribution.** The unit contribution is the amount from each sale available to cover fixed costs or to generate operating income after the fixed costs have been covered. **Contribution margin** is a measure of contribution as a percentage of the sales price.

Fixed Costs

Fixed costs are costs that do not change in total as the level of production changes, as long as production remains within the relevant range. The **relevant range** is the range of activity within which the fixed cost remains unchanged. If the activity level is above or below the relevant range, the total fixed cost increases or decreases; but as long as the production activity remains within the relevant range, an increase in the activity will not cause an increase in total fixed costs and a decrease in the activity will not cause a decrease in total fixed costs.

Examples of fixed manufacturing overhead include factory rent, depreciation on production equipment, and the plant superintendent's salary. Fixed overhead in administrative areas includes management and administrative salaries and costs for physical facilities such as rent, furniture, and equipment.

Fixed costs are best explained by using production in a factory as an example. A factory has the capacity to produce a certain maximum number of units. As long as production is between zero and that maximum number of units, the fixed cost for the factory will remain unchanged. However, once the level of production exceeds the capacity of the factory, the company will need to build (or otherwise acquire) a second factory. Building the second factory will increase the fixed costs as the company moves to another relevant range.

Within the relevant range of production, the **total fixed costs will remain unchanged**, but the **fixed costs per unit will decrease as the level of production increases**.

Note: In an exam question, if a change in volume results in a volume that is outside the relevant range given in the question, the question will provide information that would enable recalculation of the total fixed costs at the changed volume. If a question does not mention anything about the relevant range, assume that any changes in volume are within the relevant range and that fixed costs do not change in total because of the change in volume.

Note: **Over a long enough period, all costs will behave like variable costs**. Fixed costs such as property, plant, and equipment are fixed in the short term; but over a longer period of time, the company can expand its factory or move to another facility, so fixed costs become variable.

Note: Period costs can be fixed or variable, and production costs can also be fixed or variable.

[80] In some situations, direct labor may be considered a fixed cost, for example in the calculation of throughput contribution margin, covered later under *Theory of Constraints* in *Supply Chain Management*, but those situations are not relevant for this discussion.

Mixed Costs

Many costs are mixed costs. Mixed costs have a combination of fixed and variable elements. Mixed costs may be semi-variable costs or semi-fixed costs, which are also called step costs or step variable costs.

A **semi-variable cost** has both a fixed component and a variable component. It has a basic fixed amount that must be paid regardless of the amount of activity (or even in the event of no activity) and added to that fixed amount is an amount that varies with activity. Utilities provide an example. Some utility contracts incorporate a basic fixed fee per month plus a separate variable charge per unit used. The fixed component does not change, but the total cost increases incrementally by the amount of the variable component as production activity increases.

Another example of a semi-variable cost is that of a salesperson who receives a base salary plus a commission for each sale made. The base salary is the fixed component of the salesperson's salary, and the commission is the variable component.

A **semi-fixed cost**, also called a **step cost** or a **step variable cost**, is fixed over a given, small range of activity, and above that level of activity, the cost suddenly jumps. It stays fixed again for a while at the higher range of activity, and when the activity moves out of that range, it jumps again. A semi-fixed cost or step variable cost moves upward in a step fashion, staying at a certain level over a small range and then moving to the next level quickly. All fixed costs behave this way, and a wholly fixed cost is also fixed only as long as activity remains within the relevant range. However, **a semi-fixed cost is fixed over a smaller range than the relevant range of a wholly fixed cost**.

Example: The nursing staff in a hospital is an example of a semi-fixed cost. The hospital needs one nurse for every 25 patients, so each time the patient load increases by 25 patients an additional nurse will be hired. When each additional nurse is hired, the total cost of nursing salaries jumps by the amount of the additional nurse's salary.

In contrast, hospital administrative staff salaries remain fixed until the patient load increases by 250 patients, at which point an additional admitting clerk is needed. The administrative staff salaries are wholly fixed costs over the relevant range, whereas the nursing staff salaries are semi-fixed costs because the relevant range for the administrative staff (250 patients) is greater than the relevant range for the nursing staff (25 patients).

Note: The difference between a semi-variable and a semi-fixed cost (also called a step cost or a step variable cost) is that the semi-variable cost starts out at a given base level (the fixed element) and moves upward smoothly from there as activity increases. A semi-fixed cost moves upward in steps.

Introduction to Cost Measurement Methods

Costs are allocated to units manufactured in three main ways:

1) **Standard** costing
2) **Normal** costing
3) **Actual** costing

These three cost measurement methods are used for allocating both direct manufacturing costs (direct labor and direct materials) and indirect manufacturing costs (overhead) so the products manufactured can be valued.

1) Standard Costing

In a **standard cost system**, standard, or planned, costs are assigned to units produced. The standard cost of producing one unit of output is based on the standard cost for one unit of each of the inputs required to produce that output unit, with each input multiplied by the number of units of that input **allowed** for one unit of output. The inputs include direct materials, direct labor and allocated overhead. The standard cost is what the cost **should be** for that unit of output.

Note: Overhead costs are costs that cannot be traced directly to a specific product or unit. Overheads are of two main types: manufacturing (or factory) overheads and nonmanufacturing overheads.

Manufacturing overheads are overheads related to the production process (factory rent and electricity, for example), and they are allocated to units produced along with direct materials and direct labor. Under absorption costing, the production costs become a part of the cost of the units produced. That cost is held in inventory until the units it is attached to are sold, and then it becomes an expense on the income statement as cost of goods sold. Manufacturing overheads and manufacturing direct costs are the subject of the current discussion.

Nonmanufacturing overheads are not related to the production process. Examples of nonmanufacturing overheads are accounting, advertising, sales, legal counsel and general corporate administration costs. Nonmanufacturing overheads are expensed as they are incurred and are not the subject of this discussion.

Direct materials and direct labor are applied to production by multiplying the **standard** price or rate per unit of direct materials or direct labor by the **standard** quantity of direct materials or direct labor **allowed for the actual output**. For example, if three direct labor hours are allowed to produce one unit and 100 units are produced, the standard number of direct labor hours allowed for those 100 units is 300 hours (3 hours per unit × 100 units). The standard cost for direct labor for the 100 units is the standard hourly wage rate multiplied by the 300 hours **allowed** for the actual output, **regardless of how many direct labor hours were actually worked and regardless of what actual wage rate was paid**. The cost applied to the actual output is the standard cost allowed for the actual output.

Note: In a standard cost system, the **standard quantity of an input allowed** for the actual output—not the actual quantity of the input **used** for the actual output—and the **standard price allowed** per unit of the input, not the actual price **paid** per unit of the input, are used to calculate the amount of the input's cost applied to production. Some candidates find that a difficult concept to grasp, because it requires using the **standard** price per unit of the input and the **standard** quantity of the input allowed per unit of output with the **actual** number of units produced.

The standard cost of an input such as direct materials for one unit of output is:
Standard price per unit of the input × standard quantity of the input allowed per unit of output

The standard cost of an input such as direct materials for 100 units of output is:
Standard price per unit of the input × standard quantity of the input allowed per unit of output × 100

In a standard cost system, overhead is generally allocated to units produced by calculating a **predetermined**, or standard, manufacturing overhead rate (a volume-based method) that is applied to the units produced on the basis of the standard amount of the allocation base **allowed** for the actual output. When a traditional method of overhead allocation is used, the predetermined standard manufacturing overhead application rate is calculated as the budgeted overhead cost divided by the budgeted activity level of the allocation base.

The predetermined overhead application rate is calculated as follows:

$$\frac{\textbf{\textit{Budgeted} Monetary Amount of Manufacturing Overhead}}{\textbf{\textit{Budgeted} Activity Level of Allocation Base}}$$

The best cost driver to use as the allocation base is the measure that best represents what causes overhead cost to be incurred.

The most frequently used allocation bases are direct labor hours, direct labor costs, or machine hours. For a labor-intensive manufacturing process, the proper allocation base is probably direct labor hours or direct labor costs. For an equipment-oriented manufacturing process, number of machine hours is the better allocation base.

To apply overhead cost to production, the predetermined overhead rate is multiplied by the **standard amount** of the allocation base **allowed** for producing one unit of product, and then that standard overhead amount for one unit is multiplied by the **actual number of units produced** to calculate the standard overhead cost to be applied to the units produced.

Example: A manufacturer using standard costing applies variable overhead to production using machine hours as the allocation base. The standard number of machine hours allowed per unit of output is 0.25 hours. The manufacturer plans to produce 2,000 units during the coming period. Therefore, the budgeted activity level of the allocation base, machine hours, is 0.25 hours per unit of output × 2,000 units, or 500 machine hours.

The budgeted variable manufacturing overhead cost for the period is $10,000. Therefore, the predetermined standard variable overhead application rate per machine hour is $10,000 ÷ 500 standard machine hours for the budgeted output, or $20 per machine hour. The variable overhead is applied to the actual units produced based on the number of machine hours **allowed** per unit actually produced.

A total of 2,500 units are actually produced, exceeding the budgeted production level by 500 units. The standard number of machine hours allowed for the actual output is 0.25 machine hours per unit × 2,500 units produced, or 625 machine hours. The variable overhead applied to production is 625 machine hours allowed × $20 per machine hour, or $12,500.

The amount of variable overhead applied to production can also be calculated on a per-unit basis. Since the standard quantity of machine hours allowed is 0.25 hours per unit, the variable overhead applied to each unit, at the predetermined rate, is $20 × 0.25 machine hours, or $5. The amount of overhead applied to the 2,500 units actually produced is 2,500 units × $5 per unit or $12,500.

Because actual production exceeded budgeted production, the actual variable overhead incurred exceeded the budgeted variable overhead. The actual variable overhead incurred was $12,000, $2,000 greater than the budgeted overhead.

As in the preceding example, the actual production will probably always be different from the budgeted production and the actual costs incurred will probably always be different from the budgeted costs used to determine the allocation of the overhead. The difference between the actual overhead cost incurred and the overhead cost applied to production is called an **under-applied** or **over-applied** overhead cost, also called a **variance**. At the end of each accounting period, variances are accounted for in one of two basic ways.

1) If the variances are immaterial, they may be closed out 100% to cost of goods sold expense on the income statement.

2) If the variances are material, they should be prorated among cost of goods sold and the relevant Inventory accounts on the balance sheet (generally finished goods and work-in-process inventories) according to the amount of overhead cost included in each that was allocated to the current period's production.

If the variances are closed out 100% to cost of goods sold, the inventory cost of the units produced will be equal to the standard cost of the units only.

Note: In a standard cost system, both direct inputs to production such as direct materials and direct labor as well as overhead are applied to units produced on the basis of the standard cost allowed per unit multiplied by the actual number of units produced.

Standard costing enables management to compare actual costs with what the costs **should have been** for the actual amount produced. Moreover, it permits production to be accounted for as it occurs. Using actual costs incurred for manufacturing inputs would cause an unacceptable delay in reporting, because those costs may not be known until well after the end of each reporting period, when all the invoices have been received.

The emphasis in standard costing is on flexible budgeting, where the flexible budget for the actual production is equal to the standard cost per unit of output multiplied by the actual production volume.

Standard costing can be used in either a process costing or a job-order costing environment.

Note: The standard cost for each direct input per completed unit is the standard rate per unit of input multiplied by the amount of inputs **allowed** per completed unit, **not** multiplied by the actual amount of inputs **used** per completed unit.

Standard costing is applicable to manufacturing companies but also to other companies such as retail or service companies.

1) Manufacturing companies use standard costing with flexible budgeting to control direct inputs to production—direct materials and direct labor and their costs—as well as manufacturing overhead costs.

2) Retailers and service companies use standard costs to control their direct inputs and overhead, too. For example, direct inputs for a fast-food restaurant include food costs and labor. Examples of overhead costs for a fast-food restaurant are the manager's salary, rent for the premises, utilities, and janitorial costs.

2) Normal Costing

In a normal cost system, **direct materials** and **direct labor** costs are applied to production differently from the way they are applied in standard costing. In normal costing, direct materials and direct labor costs are applied at their **actual** rates per unit of input multiplied by the **actual amount of the direct inputs used** for production.

To apply overhead to production, a normal cost system uses a predetermined manufacturing overhead application rate that is calculated the same way as the predetermined manufacturing overhead application rate is calculated under standard costing:

$$\frac{\textit{Budgeted}\ \text{Monetary Amount of Manufacturing Overhead}}{\textit{Budgeted}\ \text{Activity Level of Allocation Base}}$$

However, under normal costing, that predetermined overhead application rate is multiplied by the **actual amount of the allocation base that was used** in producing the product, whereas under standard costing, the predetermined rate is multiplied by the amount of the allocation base **allowed** for producing the product.

Furthermore, in a normal costing system, the predetermined manufacturing overhead application rate is called a **normal rate** or **normalized rate**.

Normal costing is not appropriate in a process costing environment because it is too difficult to determine the actual costs of the specific direct materials and direct labor used for a specific production run. Process costing is used when many identical or similar units of a product or service are being manufactured, such as on an assembly line. Costs are accumulated by department or by process. In contrast, job costing accumulates costs and assigns them to specific jobs, customers, projects, or contracts. Job costing is used when units of a product or service are distinct and separately identifiable. **Normal costing is used mainly in job costing**.

The purpose of using a predetermined manufacturing overhead application rate in normal costing is to normalize factory overhead costs and avoid month-to-month fluctuations in cost per unit that would be caused by variations in actual overhead costs and actual production volume. It also makes current costs available, though at the budgeted rate rather than at the actual rate. If actual manufacturing overhead costs were used, those costs might not be known until well after the end of each reporting period, when all the invoices had been received.

3) Actual Costing

In an actual costing system, no predetermined or estimated or standard costs are used. Instead, the actual direct labor and materials costs and the actual manufacturing overhead costs are allocated to the units produced. The cost of a unit is the actual direct cost rates per unit of input multiplied by the actual quantities of the direct cost inputs used and the actual indirect (overhead) cost rates multiplied by the actual quantities used of the cost allocation bases.

Actual costing is practical only for **job order costing** for the same reasons that normal costing is practical only for job order costing. In addition, actual costing is **seldom used** because it can produce costs per unit that fluctuate significantly. This fluctuation in costs can lead to errors in management decisions such as pricing of the product, decisions about adding or dropping product lines[81], and performance evaluations.

[81] A "product line" is a group of related products that are all marketed under the same brand name and sold by the same company.

Variable and Absorption Costing

Variable and absorption costing are two different methods of inventory costing. Under both variable and absorption costing, all **variable** manufacturing costs (both direct and indirect) are inventoriable costs. The only two differences between the two methods are in:

1) Their treatment of fixed manufacturing overhead
2) The income statement presentation of the different costs

Note: All other costs except for fixed factory overheads are treated in the same manner under both variable and absorption costing, although they may be reported in a slightly different manner on the income statement.

Fixed Factory Overheads Under Absorption Costing

For a manufacturing company, absorption costing is required for external financial reporting by generally accepted accounting principles. Under absorption costing, fixed factory overhead costs are allocated to the units produced during the period according to a predetermined rate.[82] Fixed manufacturing overhead is therefore a **product cost** under absorption costing.

Product costs are inventoried (that is, debited to an inventory account instead of to an expense account), and they are expensed as cost of goods sold only when the units they are attached to are sold.

Fixed Factory Overheads Under Variable Costing

Under variable costing (also called **direct costing**), fixed factory overheads are reported as **period costs** and are expensed in the period in which they are incurred. Thus, no matter what the level of sales, all the fixed factory overheads will be expensed in the period when incurred.

Variable costing does not conform to GAAP. For external reporting purposes, **GAAP requires the use of absorption costing**, and therefore variable costing cannot be used for external financial reporting. However, many accountants feel that variable costing is a better tool than absorption costing for internal analysis, and therefore variable costing is often used internally.

Note: It is important to remember that the only difference in operating income between absorption costing and variable costing relates to the treatment of **fixed factory overheads**. Under absorption costing, fixed factory overhead costs are included, or absorbed, into the product cost and reach the income statement as part of cost of goods sold when the units the fixed costs are attached to are sold. Under variable costing, only variable direct costs (direct materials and direct labor) and variable indirect costs (variable overhead) are included as product costs. Fixed factory overhead costs are **excluded** from the product cost and treated as a period cost.

Note: Variable costing can be used only **internally** for decision-making. Variable costing is not acceptable for external financial reporting under generally accepted accounting principles because fixed manufacturing overhead is not accounted for as a product cost. Variable costing is also not acceptable for income tax reporting under U.S. tax regulations.

[82] When standard costing is being used, the predetermined fixed overhead application rate is called the "standard rate." When normal costing is being used, the predetermined fixed overhead application rate is called the "normal rate" or "normalized rate." The predetermined rate is calculated the same way under both standard and normal costing: Budgeted fixed manufacturing overhead divided by the budgeted activity level of the allocation base being used.

Income Statement Presentation

The presentation of the income statement will also be different under absorption costing and variable costing. An allocation of fixed manufacturing costs is included in Cost of Goods Sold under absorption costing but under variable costing, fixed manufacturing costs are expensed as incurred.

The Income Statement under Absorption Costing

Under absorption costing **gross profit** is calculated by subtracting from revenue the cost of goods sold, which includes **all variable and fixed manufacturing costs for goods sold**. All variable and fixed **non**-manufacturing costs (period costs) are then subtracted from gross profit to calculate operating income.

The income statement (through operating income) under **absorption costing** is as follows:

	Sales revenue
–	Cost of goods sold – *variable direct inputs, variable and fixed manufacturing overhead costs of items sold*
=	Gross profit
–	Variable nonmanufacturing costs (expensed)
–	Fixed nonmanufacturing costs (expensed)
=	Operating Income

The Income Statement under Variable (Direct) Costing

Under variable costing a **manufacturing contribution margin** is calculated by subtracting all **variable manufacturing costs (direct inputs and overhead) for goods that were sold** from revenue. From this manufacturing contribution margin, **non**manufacturing variable costs are subtracted to arrive at the **contribution margin**. All fixed costs (manufacturing and non-manufacturing) are then subtracted from the contribution margin to calculate operating income.

The income statement under **variable costing** is as follows:

	Sales revenue
–	Variable manufacturing costs of items sold – *variable direct inputs and variable manufacturing overhead costs of items sold*
=	Manufacturing contribution margin
–	Variable nonmanufacturing costs (expensed)
=	Contribution Margin
–	Fixed manufacturing overhead costs (expensed)
–	Fixed nonmanufacturing costs (expensed)
=	Operating Income

Note: The difference in presentation between the two methods does not affect the difference in the treatment of fixed manufacturing overheads under the two different methods. Candidates need to know that under the absorption method a **gross profit** is reported, while under the variable method a **contribution margin** is reported; and the two are different.

The difference is demonstrated in the example (and the answer to the example) that follows this explanation.

Process Costing and Job Order Costing

Cost accumulation systems are used to assign costs to products or services. Job order costing (also called job costing) and process costing are different systems of cost accumulation used in manufacturing.

1) **Process costing** is used when many identical or similar units of a product or service are being manufactured, such as on an assembly line. Costs are accumulated by department or by process. Process costing is used when the manufacturing process is similar between different products and the main difference is in the raw materials. A clothing factory is a good example of an operation that probably uses process costing. The shirts that are made are all made in basically the same way, with the main difference between different models of shirts is the fabric that goes into the shirts.

2) **Job order costing** (also called **job costing**) is used when units of a product or service are distinct and separately identifiable. Costs are accumulated by job. Accounting firms and lawyers use job order costing to allocate costs (largely labor) to the different, specific jobs that the company has.

Study Unit 33: D.2. Variable and Fixed Overhead Expenses

In general, overheads are costs that cannot be traced directly to a specific product or unit. Overheads are of two main types: manufacturing (or factory) overheads and nonmanufacturing overheads. Manufacturing overheads are overheads related to the production process (factory rent and electricity, for example), whereas nonmanufacturing overheads are not related to the production process. Examples of nonmanufacturing overheads are accounting, advertising, sales, legal counsel and general corporate administration costs.

The allocation of manufacturing overheads is covered first in the topic that follows. Allocation of manufacturing overheads can be accomplished by a variety of methods that include traditional allocation, process costing, job order costing, activity-based costing, and life-cycle costing. All those methods, except for life-cycle costing, can be used for external financial reporting, although some of the principles of activity-based costing must be adapted in order for it to be used for external reporting because in principle, activity-based costing does not conform to generally accepted accounting principles. Methods that cannot be used for external financial reporting can be used internally for decision-making.

The allocation of nonmanufacturing overheads is covered next in *Shared Services Cost Allocation*. However, some of the concepts and ideas covered in manufacturing overhead are also applicable in the allocation of nonmanufacturing overheads.

Manufacturing Overhead Allocation

Note: To help the following explanations flow more easily, the term "overhead" will be used in the majority of situations, even though the term "manufacturing overhead" would be more technically accurate. If "manufacturing overhead" were used in every situation, the language would become cumbersome and be more difficult to read. Also, the term "factory overhead" can be used in place of "manufacturing overhead" because the two are interchangeable terms.

The three main classifications of production costs are:

1) Direct materials
2) Direct labor
3) Manufacturing (or factory) overhead

Direct materials (DM) and direct labor (DL) are usually simple to trace to individual units or products because direct materials and direct labor costs are directly and obviously part of the production process. Therefore, the FMAA exam does not put much emphasis on the determination of DM and DL. Rather, the emphasis is on the allocation of overhead.

Overhead costs are production and operation costs that a company cannot trace to any specific product or unit of a product. Because overhead costs are incurred and paid for by the company and are necessary for the production process, it is essential that the company know what these costs are and allocate them to the various products being manufactured. Allocation to products manufactured must occur so that the full costs of production and operation are known in order to set the selling prices for the different products. If a company does not take overhead costs into account when it determines its selling price for a product, it runs a significant risk of pricing the product at a loss because the price the company charges may cover the direct costs of production but not the indirect costs of production.

Furthermore, generally accepted accounting principles require the use of absorption costing for external financial reporting because all the costs of producing a unit of product should be treated as product costs, associated with the finished goods inventory cost of that unit, and all the costs of the unit should be carried as an asset until that unit is sold.

Because fixed overhead is a necessary cost of production, it is included in the inventoriable costs under absorption costing. **All** overhead costs associated with manufacturing a product become a part of the product's inventoriable cost along with the direct costs. Therefore, **all** manufacturing overhead costs must be allocated to the units produced.

The categories of costs included in **factory overhead** (OH) are:

1) **Indirect materials** – materials not identifiable with a specific product or job, such as cleaning supplies, small or disposable tools, machine lubricant, and other supplies.

2) **Indirect labor** – salaries and wages not directly attributable to a specific product or job, such as those of the plant superintendent, janitorial services, and quality control.

3) **General manufacturing overheads**, such as facilities costs (factory rent, electricity, and utilities) and equipment costs, including depreciation and amortization on plant facilities and equipment.

> **Note**: Remember that **factory overhead** and **manufacturing overhead** are interchangeable terms that mean the same thing. Either may be used in a question.

Overheads may be fixed, variable, or mixed.

1) **Variable overheads** are costs that change in total as the level of activity changes. The per-unit cost is assumed to remain the same, even though direct material costs per unit may decline slightly with increased activity because of quantity purchasing discounts available from suppliers. But even if costs per unit decline slightly with increased activity, variable costs remain variable, and they continue to change in total as the level of activity changes. Examples of variable manufacturing overheads are indirect materials and equipment maintenance. Examples of variable non-manufacturing overheads are selling costs such as sales commissions and shipping-out costs.

2) **Fixed overhead** does not change with changes in activity as long as the activity remains within the relevant range. Examples of fixed manufacturing overhead are factory rent, depreciation on production equipment, and the plant superintendent's salary.

3) **Mixed overheads** contain elements of both fixed and variable costs. Electricity is an example of a mixed overhead cost because electricity may be billed as a basic fixed fee that covers a certain number of kilowatts of usage per month and usage over that allowance is billed at a specified amount per kilowatt used. A mixed overhead cost could also be an allocation of overhead cost from a cost pool containing both fixed and variable overhead costs.

Over a long enough time period, all costs will behave like variable costs. Fixed costs such as property, plant, and equipment are fixed in the short term; but over a longer period of time, the company can expand its factory or move to another facility, so fixed costs are variable over a long term. However, for decision purposes, fixed costs are assumed to be fixed during the period in question.

The number of ways in which a company can allocate manufacturing overhead are numerous and limited only by the imagination of the accountant and the computer programmer. However, for the FMAA exam, candidates need to be familiar with only the primary methods of manufacturing overhead allocation. The primary methods are the **traditional** overhead allocation method and **activity-based costing**.

1) The **traditional** method of overhead allocation involves grouping all manufacturing overhead costs into a cost pool[83] and allocating them to individual products based on a single cost driver,[84] such as direct labor hours or machine hours. The cost driver used for the allocation is called the allocation base. Traditional overhead allocation may involve the use of separate cost pools for fixed overhead

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[83] A **cost pool** is a group of indirect costs that are being grouped together for allocation based on some cost allocation base.

[84] A **cost driver** is anything (it can be an activity, an event or a volume of something) that causes costs to be incurred each time the driver occurs.

and variable overhead, though fixed and variable overhead may also be combined into a single cost pool.

2) **Activity-based costing** (**ABC**) involves using multiple cost pools and multiple cost drivers to allocate overhead on the basis of a cost driver specific to each cost pool. Activity-based costing in its pure form does not conform to GAAP and thus cannot be used for external financial reporting. Product costs used in external financial reports must include all manufacturing costs and only manufacturing costs, whereas under pure activity-based costing, some manufacturing costs are excluded and some non-manufacturing costs are included in the cost pools. However, if activity-based costing is adapted so that all manufacturing overhead costs and only manufacturing overhead costs are included in the cost pools used for allocation to products that are inventoried, ABC can be used for external financial reporting.

Regardless of the manner of allocation used, overhead allocation is simply a **mathematical exercise of distributing the overhead costs to the products that were produced** using some sort of allocation base and formula.

Traditional (Standard) Allocation Method

Traditionally, manufacturing overhead costs have been **allocated to the individual products** based on either the direct labor hours, machine hours, materials cost, units of production, weight of production or some similar measure that is easy to measure and calculate. The measure used is called the **activity base**.

For example, if a company allocates factory overhead based on direct labor hours, for every hour of direct labor **allowed** per unit of output (under standard costing) or **used** per unit of output (under any other type of cost measurement system), a certain amount of factory overhead is allocated to, or **applied** to, each unit actually produced. The determination of how much overhead is allocated per unit is covered below.

By summing the direct materials, direct labor, and allocated manufacturing overhead costs, a company determines the total cost of producing each specific unit of product.

Determining the Allocation Base

When choosing the allocation base (for example, direct labor hours or machine hours), the base used should closely reflect what causes costs to be incurred. For example, in a highly automated manufacturing environment, direct labor would most likely not be a good allocation base for factory overhead because labor would not be a large part of the production process. Machine hours would probably be a better allocation base to use.

However, the allocation base does not need to be direct labor hours or machine hours, though those are the most common bases used. For example, in a company that produces very large, heavy items (such as an appliance manufacturer), the best allocation base for overhead may be the weight of each product.

Plant-Wide versus Departmental Overhead Allocation

A company can choose to use plant-wide overhead allocation or departmental overhead allocation.

Plant-wide overhead allocation involves putting all the overhead costs for the whole plant into one cost pool and allocating the costs in that cost pool to products using one allocation base. The allocation base is a measure of activity such as direct labor hours or machine hours that is used to assign costs to cost objects.

> **Note**: When production in a plant is limited to only one product or to similar products with minimal differences, using only one overhead application rate for the whole plant may be appropriate.

Alternatively, a company can choose to have a separate cost pool for each department that the products pass through in production. This second method is called **departmental overhead allocation**. Each department's overhead costs are put into a separate cost pool, and then each department's overhead is allocated according to the allocation base that managers believe is best for that department.

In both plant-wide and departmental overhead allocation, fixed overhead costs can be segregated in a separate cost pool from variable overhead costs and the fixed and variable overheads allocated separately. The fixed and variable overheads can be allocated using the same allocation base, or they can be allocated using different allocation bases. For planning purposes and in order to calculate fixed and variable overhead variances, it is virtually essential to segregate fixed and variable overhead costs.

Note: An **allocation base**, or **basis of cost allocation**, is a measure of activity such as direct labor hours or machine hours (a **cost driver**) that is used to assign costs to cost objects. A **cost object** is a function, organizational subdivision, contract, or other work unit for which cost information is desired and for which provision is made to accumulate and measure the cost of processes, products, jobs, capital projects, and so forth.

To best reflect the way that manufacturing overhead is incurred, **departmental overhead allocation** is preferable to plant-wide overhead allocation. The greater the number of manufacturing overhead allocation rates used, the more accurate and more meaningful the overhead allocation will be, which is helpful for developing product costs for use in setting prices and making other decisions. However, departmental overhead allocation requires a lot more administrative and accounting time than plant-wide allocation and thus is costlier. The more allocation bases that are used to allocate overhead, the more costs will be incurred to obtain the needed information for the allocation. Therefore, a company needs to find a balance between the usefulness of having more than one overhead allocation basis against the cost of making the needed calculations for the additional bases.

Departmental overhead allocation would be chosen by a company's management if it felt the benefit of the additional information produced would be greater than the cost to produce the information. For example, the additional information could be used to develop more accurate product costs for use in setting prices and making other decisions.

Note: When process costing is being used and products pass through several different processes or departments before becoming finished goods, departmental overhead allocation is essential so that each department's overhead costs can be applied to the units worked on in that department as production activities take place and the units move from department to department.

Example: Department A uses very little direct labor but a lot of machine time, Department B uses a lot of direct labor and very little machine time, Department C does the final assembly of the products, and Department D is responsible for painting the products as the last step in their manufacture.

- Department A's overhead costs are allocated to products using machine hours as the allocation base.
- Department B's overhead costs are allocated to products using direct labor hours as the allocation base.
- Department C's overhead costs are allocated to products using number of parts in each product as the allocation base.
- Department D's overhead costs are allocated to products using the size of the painted area on each product as the allocation base.

Calculating the Predetermined Manufacturing Overhead Allocation Rate

Once the allocation base for manufacturing overhead has been determined, the **predetermined manufacturing overhead allocation rate** is calculated. The predetermined rate is the amount of manufacturing overhead that will be charged (allocated) to each unit of a product for each unit of the allocation base (direct labor hours, machine hours, and so on) **allowed** for the production of that product (if standard costing is being used) or **used** in the production of that product (if normal costing is being used).

The predetermined overhead rate may be a combined rate including both variable and fixed overheads; or it may be calculated separately for variable overhead and fixed overhead and applied separately. Whichever way it is done, the total overhead allocated to production will be the same if the same allocation base is used for both fixed and variable overhead.

> **Note**: It is important to note that **fixed overhead is applied to units produced as if it were variable overhead**, even though fixed costs do not behave the same way variable costs behave. Actual variable costs increase in total as production increases and decrease in total as production decreases. However, as long as the production level remains within the relevant range, fixed manufacturing costs do not change in total as production increases and decreases. Instead, fixed manufacturing cost **per unit** changes as the production level increases and decreases.

Although actual fixed manufacturing overhead may not vary much in total from budgeted fixed manufacturing overhead, the variance between the amount of actual fixed manufacturing overhead incurred and the amount of fixed manufacturing overhead **applied to production** can be significant because of the fact that fixed overhead is applied to production the same way variable overhead is, on a per-unit basis, but it is not incurred that way. Therefore, the fixed manufacturing overhead component of total overhead costs creates a large part of the reported variances.

The rate used to allocate overhead is usually **calculated at the beginning of the year**, based on budgeted overhead for the coming year and the budgeted level of activity for the coming year.

Unless changes in actual overhead costs occur during the year that are material enough to necessitate a change to the predetermined rate, that rate (or those rates, if fixed and variable overheads are allocated separately) will be used to allocate manufacturing overheads throughout the year. Because the manufacturing overhead allocation rate is set before the production takes place, it must be calculated with **budgeted** amounts. The manufacturing overhead allocation rate is called the **predetermined rate** because it is calculated at the beginning of the period.

> **Note**: It is important to remember that the manufacturing overhead allocation rate is calculated at the beginning of the year and then used throughout the year unless it becomes necessary to change it during the year.

The predetermined overhead rate is calculated as follows:

$$\frac{\textbf{\textit{Budgeted} Monetary Amount of Manufacturing Overhead}}{\textbf{\textit{Budgeted} Activity Level of the Allocation Base}}$$

The **budgeted activity level of the allocation base** is the number of budgeted direct labor hours, direct labor cost, material cost, or machine hours—whatever is being used as the allocation base—**allowed** for the budgeted output. The budgeted activity level will be discussed in greater detail later in this explanation.

However, as noted above, the application rate should be reviewed periodically and adjusted if necessary, so that the amount applied is a reasonable approximation of the current overhead costs per unit.

Note: Since the predetermined rate is a calculated rate using Budgeted Manufacturing Overhead divided by Budgeted Activity Level of the Allocation Base, the predetermined rate and the budgeted activity level can easily be used to reverse the process and calculate the budgeted overhead amount that was used to calculate the predetermined rate. Such an exercise will frequently be required, particularly for fixed overhead.

Predetermined rate × Budgeted Activity (Production) Level = Budgeted Manufacturing Overhead

The above formula is particularly important to remember when working with fixed manufacturing overhead, since **neither actual nor budgeted fixed overhead is affected in total by the actual number of units produced or the actual amount of the allocation base used** as long as production remains within the relevant range.

Only the amount of fixed overhead *applied* is affected by the actual production activity level.

It is critical to use the **budgeted amount of manufacturing overhead** for the numerator and the **budgeted activity level of the allocation base** for the denominator in calculating the predetermined overhead allocation rate. Do not use budgeted for one and actual for the other.

1) The budgeted amount of manufacturing overhead is the cost the company expects to incur during the budget period.

2) The budgeted production is the number of units the company expects to produce during the same period.

3) The budgeted **activity level** is the number of units of the allocation base **allowed** for the budgeted production during the upcoming year.

The company calculates the predetermined overhead allocation rate at the beginning of the year and uses it for the entire year for the application of the manufacturing overhead costs unless something changes that requires the allocation rate to be adjusted.

Note: The calculation of the predetermined overhead allocation rate can also be done on a weekly or a monthly basis. In such a situation, the process would be exactly the same except that the budgeted overhead cost and activity level used would be for the upcoming week or month (or whatever time period is used).

Clearly, the predetermined overhead allocation rate is not going to be the actual rate that occurs during the year. However, an estimated rate must be used in order to determine the cost of goods produced throughout the year so their cost can flow to inventory when produced and then to cost of goods sold when they are sold. A company cannot wait until the end of the year to determine what its cost of production was. If the rate is reviewed periodically and adjusted when necessary, however, variances can be minimized.

Activity Based Costing (ABC)

The traditional method of allocating indirect costs has several limitations. In addition, when traditionally allocated cost information is used to control costs, managers may try to reduce the cost of over-costed products when instead, they may need to focus on cost management for products that are under-costed because those products may be using high levels of resources.

Activity-based costing (ABC) is another way of allocating overhead costs to cost objects (usually products, services, or customers), and it is based on cost drivers.

A **cost driver** is a measure of a resource consumed by an activity that causes costs to be incurred. A cost driver can also be a measure of an activity consumed by a cost object.

Cost drivers used in activity-based costing can be **resource consumption cost drivers** or **activity consumption cost drivers**.

The premise of activity-based costing is that an organization's products or services are the results of activities; activities use resources, which incur costs; and the costs for activities can be allocated to cost objects according to their usage of the activities. ABC is used to trace overhead costs to cost objects by identifying resources and their costs, the consumption of the resources by activities, and the consumption of the activities by cost objects.

Note: Activities consume resources; and cost objects such as products, services, and customers consume activities.

As with other overhead allocation methods, ABC is a mathematical process. It requires identification of the costs to be allocated followed by some manner of allocating them to departments, processes, products, or other cost objects. ABC can be used in a variety of situations and can be applied to both manufacturing and nonmanufacturing overheads incurred by a manufacturer. It can also be used nonmanufacturing businesses, including service businesses.

Study Unit 34: D.3. Cost and Variance Measures

Variance analysis is the process of comparing the actual expenses and revenues during a certain period to the budgeted amounts for that same period. Variance analysis shows management where the differences are between actual and budgeted amounts, enabling management to investigate to determine the reasons for the variances. Knowing the reasons can help management to focus its efforts on the areas that have been operating less efficiently than planned.

Variances and Management by Exception

The comparison of actual costs to standard costs and the calculation of variances enables a company to analyze its actual costs and undertake some cost controls. A large variance between the actual cost and the standard cost alerts management that something may be wrong and may need attention.

In a system where variances are identified and reported to the appropriate level of the company, management can manage by exception once the standards have been set. Management by exception refers to a system whereby only significant variances between actual results and the budget or plan are brought to the attention of management. Management by exception focuses management's attention on the things that have the highest priority, defined as the greatest variances.

In manufacturing variances, which this topic focuses on, the detailed causes of the variances provide information about whether the actual quantity of inputs was different from the budgeted quantity and whether the actual price per unit of inputs was different from the budgeted price.

Because of the nature of variances, all the variance calculations made will be comparisons between an actual amount and a budgeted amount. What is specifically compared will depend on the variance being calculated.

The Flexible Budget Variance and Sales Volume Variance

The **flexible budget variance** is the difference between the actual results and the flexible budget amount.

Flexible Budget Variance = Actual Results – Flexible Budget Amount

The flexible budget amount on a variance report is budgeted amounts that have been adjusted to the actual level of sales activity that has occurred. The flexible budget variance indicates how much of the static budget variance was caused by factors **other than** the difference between actual and budgeted sales volume. For example, the flexible budget variance on the revenue line indicates how much of the static budget variance was due to a difference between the actual price charged for each unit sold and the budgeted price per unit.

The **sales volume variance** on a sales variance report is the difference between the flexible budget amount and the static budget amount.

Sales Volume Variance = Flexible Budget Amount – Static Budget Amount

The sales volume variance shows how much of the static budget variance was caused by actual sales volume having been different from budgeted sales volume.

These variances may be calculated for operating income and for each line item on the income statement. An example follows.

Example: Below is the example income statement again, this time showing the static budget variances, the flexible budget variances, and the sales volume variances for each line item and for net operating income.

For each line, the flexible budget variance plus the sales volume variance equals the total static budget variance. The calculation of the net operating income variances is shown at the bottom. It would be a good idea to verify the variance calculations for the individual lines to be sure of understanding how they are calculated.

Flexible Budget Variance Report

	Col. 1 Actual Results	Col. 2 (2)=(1)−(3) Flexible Budget Variances	Col. 3 Flexible Budget	Col. 4 (4)=(3)−(5) Sales Volume Variances	Col. 5 Static Budget	Col. 6 (6)=(1)−(5) also (6)=(2)+(4) Static Budget Variances
Units sold	20,000	0	20,000	4,000− U	24,000	4,000− U
Revenues	$2,500,000	$100,000+ F	$2,400,000	$480,000− U	$2,880,000	$380,000− U
Variable costs						
Direct materials	1,243,200	43,200+ U	1,200,000	240,000− F	1,440,000	196,800− F
Direct manufacturing labor	396,000	76,000+ U	320,000	64,000− F	384,000	12,000+ U
Variable manufacturing overhead	261,000	21,000+ U	240,000	48,000− F	288,000	27,000− F
Total variable costs	$1,900,200	$140,200+ U	$1,760,000	$352,000− F	$2,112,000	$211,800− F
Contribution margin	$ 599,800	$ 40,200− U	$ 640,000	128,000− U	$ 768,000	$168,200− U
Fixed costs	570,000	18,000+ U	552,000	0	552,000	18,000+ U
Operating income	$ 29,800	$ 58,200− U	$ 88,000	$128,000− U	$ 216,000	$186,200− U

$58,200− U
Total flexible budget variance

$128,000− U
Total sales volume variance

$186,200− U
Total static budget variance

Manufacturing Input Variances

Manufacturing input variances are a special class of variances. Manufacturing inputs are the direct materials, direct labor, and manufacturing overhead **used in production**. Manufacturing input variances are concerned with **inputs** to the manufacturing process, as follows:

- Whether the quantity of inputs used per unit manufactured was over or under the standard (a quantity, or efficiency, variance),
- Whether the inputs used cost more or less per unit of the input than the standard (a price variance), and
- What the monetary impact was of each type of variance.

Manufacturing input variances are used in controlling production. Manufacturing input variances are also called flexible budget variances, and the flexible budget amounts used are based on the price and quantity of the **input allowed for the actual production**. Manufacturing input variances are reported on a production variance report, not on a report in the form of an income statement, because they report on units produced, not on units sold.

In the accounting system, manufacturing input variances are closed out at the end of each period to cost of sales or, if material, they are prorated among cost of sales, finished goods inventory, work in process inventory and—for direct material variances only—direct materials inventory.

Direct Materials Variances

The total direct materials variance is also the **flexible budget variance** for direct materials. The total direct materials variance is the difference between the actual direct materials costs for the period and the standard costs for the standard quantity of materials **allowed** for the actual output at the standard price per unit of direct materials (the flexible budget).

	Actual total direct materials costs incurred (money spent)	(AP x AQ)
–	**Standard quantity of direct materials allowed for the actual output at the standard price per unit of direct materials**	(SP x SQ)
=	**Total direct materials variance**	

Example: Medina Co. produces footballs. Each football requires a standard of 1 square meter of leather that has a standard cost of $5.00. During the period, Medina produced 250 footballs and used 290 square meters of leather. The actual cost of the leather was $4.50 per square meter.

The total actual cost of the leather used was $1,305 (290 × $4.50). However, given the actual output of 250 footballs, Medina should have used only 250 square meters of leather. Since each square meter should have cost $5, Medina should have spent $1,250 on leather to produce 250 footballs (250 × $5).

The total direct materials variance is:

Actual cost for 250 units – $4.50 × 290 sq. meters used	$ 1,305	
Standard cost allowed for 250 units – $5.00 × 250 sq. meters	$ 1,250	
Total variance	**$ 55**	**U**

Medina spent $55 more than it should have spent for the leather to make 250 footballs. A manager might conclude that this situation is acceptable and does not require any significant attention because even though the variance is unfavorable, it is not large. However, a more in-depth examination will reveal that the company used a greater quantity of materials than it should have, though the financial impact of that variance was mitigated by the fact that it paid less than expected for each square meter of leather used.

Because of the need for more useful analysis, the total materials variance is divided into two components: price and quantity. The **quantity variance** (also called the efficiency or usage variance) measures how much of the variance is due to having used either more or less direct material than budgeted, and the **price variance** measures how much of the total variance was caused by having paid a different amount for the material than had been budgeted.

The **quantity variance** plus the **price variance** equals the **total variance**, which is also the **flexible budget variance**.

The Quantity Variance

The quantity variance (also called the **efficiency** or **usage variance**) is calculated as:

(Actual Quantity – Standard Quantity for Actual Output) × Standard Price
or
(AQ – SQ) × SP = Quantity Variance

The above formula is actually a shorter way of expressing the following:

	Actual Quantity × Standard Price
–	**Standard Quantity × Standard Price**
=	**Quantity Variance**

The quantity variance represents the difference in cost between the actual material used for the actual output at the standard price and the standard usage allowed for the level of actual output at the standard price.

The quantity variance formula is used to calculate the portion of the total variance that was caused by either too much or too little direct materials having been used, without any reference to the amount of the variance that was caused by a difference between the actual and the standard price per unit of the material used.

Both the actual quantity and the standard quantity for the actual output are multiplied by the standard price to remove any effect of the price variance from the result.

Because the quantity variance measures a cost variance, a positive result is an unfavorable variance because costs were higher than expected, while a negative result is a favorable variance because costs were lower than expected.

Example: In the example of Medina Co., where each football requires a standard quantity of 1 square meter of leather that has a standard cost of $5 and Medina produced 250 footballs using 290 square meters of leather, the amounts used in calculating the quantity variance are as follows:

Actual Quantity = 290 meters used
Standard Quantity = 1 meter allowed per football × 250 footballs produced, which equals 250 meters
Standard Price = $5 per meter

The **quantity variance** is **(AQ − SQ) × SP** and is calculated as:

(290 − 250) × $5 = $200 Unfavorable

The variance is **unfavorable** because it is a positive variance for a cost. The $200 variance means that Medina had to pay $200 more than it should have paid for the materials used to produce 250 footballs because it used too much material. Any variance caused by a difference between the actual price paid per meter and the standard price per meter is not reflected in the unfavorable quantity variance.

Thus, if the actual price per meter of direct materials actually used had been the same as the standard price per meter actually used (in other words, if there had been no price variance), the total direct materials variance would have been $200 Unfavorable, all due to having used too much direct materials in production.

While favorable variances are generally desirable, they are not so desirable if they are caused by standards that need to be adjusted to reflect reality. Inaccurate standards lead to poor production planning and can cause a build-up of direct materials inventory with its attendant costs. The standards should be adjusted.

Causes of Direct Materials Quantity Variances

Potential causes of an unfavorable direct materials quantity variance include:

- Low quality materials that do not meet specifications;
- Production machinery not maintained properly or not functioning properly, causing defective production and damaged inputs;
- Poor product design;
- Abnormal spoilage of work-in-process;
- Theft of direct materials;
- Anything that negatively affects production workers' performance, such as inadequate training and supervision, inexperienced workers, temporary workers, absenteeism, scheduling of substantial overtime negatively affecting workers' performance, or new production equipment installed and workers experiencing a learning curve;
- A large number of rush orders received, disrupting the manufacturing process by interfering with normal work routines.

The causes of the variances should be identified, and the identified causes should be addressed and corrected as necessary. For example, if the cause is inexperienced or temporary workers, training programs should be established and conducted regularly. If theft is taking place, it should be investigated and stopped.

Potential causes of a favorable direct materials quantity variance include:

- The purchasing department having found better quality materials to purchase so less direct material is required for each batch;
- A change was made in the engineering specifications has been made so that fewer units of direct materials are required but the quantity standard has not yet been adjusted to reflect the standard change;
- Performance of workers was better than expected, possibly due to better training or more experience.

While favorable variances are generally desirable, they are not so desirable if they are caused by standards that need to be adjusted to reflect reality. Inaccurate standards lead to poor production planning and can cause a build-up of direct materials inventory with its attendant costs. The standards should be adjusted.

The Price Variance

Though it is commonly called the "price variance" for materials, the more complete name for this variance is the "price usage variance." The variance is called the "price usage variance" to distinguish it from the "purchase price variance," which will be covered next. For the sake of brevity, from this point onward "price variance" will be used to mean the "price usage variance."

The price variance is calculated as:

(Actual Price − Standard Price) × Actual Quantity
or
(AP − SP) × AQ = Price Variance

The above formula is actually a shorter way of expressing the following:

	Actual Price × Actual Quantity
−	**Standard Price × Actual Quantity**
=	**Price Variance**

The price variance represents the difference between the actual material usage at the actual price and the actual material usage at the standard price.

The price variance formula is used to calculate the portion of the total variance that was due to a difference between what was actually paid (the actual price) per unit of direct materials used and the amount allowed (the standard or budgeted price) per unit of direct materials actually used. Both the actual price and the standard price are multiplied by the actual quantity used to remove any effect of the quantity variance from the result.

Because the materials price variance measures a cost variance, a positive result is an unfavorable variance because costs were higher than expected, while a negative result is a favorable variance because costs were lower than expected.

Example: In the Medina Co. example, where the actual cost paid per meter of leather was $4.50, the standard price was $5.00, and 290 meters were actually used in production, the amounts used in calculating the price variance are as follows:

Actual Price = $4.50 per meter

Standard Price = $5.00 per meter

Actual Quantity = 290 meters

The **price variance** is **(AP – SP) × AQ and** is calculated as:

($4.50 – $5.00) × 290 = $(145) Favorable

Medina saved $145 because the price per unit of the leather that was actually used in production was lower than expected, a **favorable variance**. A negative variance for a cost is a favorable variance because it means the actual cost per unit used was lower than the budgeted cost per unit. Even though Medina used more leather than it should have for each football it manufactured, it saved $0.50 on each square meter of leather actually used.

The variance of $(145) means that, because the price per square meter was $0.50 lower than expected, the company's cost for the 290 square meters of direct materials used was $145 lower than the standard cost allowed for that quantity of materials.

Causes of Direct Materials Price Variances

Potential causes of an unfavorable direct materials price variance include:

- Unavoidable increases have taken place in the market prices of direct materials, and the price standard has not yet been adjusted to reflect a change in the market price;
- A change in personnel in the purchasing department, causing poor purchasing decisions because of inexperienced and poorly trained employees.

If the cause is of an unfavorable direct materials price variance is unavoidable increases in market prices, there may be little that can be done about that. However, the standards should be adjusted to reflect the new market prices, and perhaps management can discover some cost savings elsewhere in the production process that can offset the price increases. If the cause of an unfavorable direct materials price variance is inexperienced employees in the purchasing department, training needs to be conducted.

Potential causes of a favorable direct materials price variance include:

- Decreases in the market price of direct materials and the price standard has not yet been adjusted to reflect a change in the market price;
- Better purchasing research resulting in finding less expensive direct materials to purchase without any loss in quality.

If the favorable direct materials price variance is caused by decreases in the market price or better purchasing research, the relevant standards should be adjusted.

Exam Tip: For the exam, candidates need to be able to use the variance formulas to solve for the variance itself and also to solve for any of the individual variables in the formulas.

For example, each variance uses three amounts to calculate the variance. In a straightforward question, the variance is the unknown. The amounts for the formula (AP, SP, AQ, or SQ) are on the left side of the equals sign and the calculated variance is on the right.

Instead, an exam question may give the variance and two of the amounts for the formula (or may give enough information to determine what the two amounts are). The question may ask for the third amount on the left side of the "equals" sign—the AP, SP, AQ, or SQ—so that amount will be the unknown. To do the calculation, simply use the same formulas but use algebra to solve for a different unknown.

The Quantity Variance Plus the Price Variance Equals the Total Variance

Assuming the total, price, and quantity variances have been calculated accurately, the quantity variance plus the price variance will equal the total variance.

Example: In the Medina Co. example, the total direct materials variance for leather is:

Actual cost for 250 units – \$4.50 × 290 sq. meters used	\$ 1,305	
Standard cost allowed for 250 units – \$5.00 × 250 sq. meters	\$ 1,250	
Total variance	**\$ 55**	**U**

The total materials variance for Medina Co. is also the sum of the quantity variance and the price variance.

Quantity variance	\$ 200	U
Price variance	(145)	F
Total Variance	**\$ 55**	**U**

In total, Medina had a positive variance of \$55, which is **unfavorable**, because the cost for the extra leather that was used was more than the savings on each square meter of leather used.

Even though Medina's total actual cost came close to the total standard cost, the company has significant production problems, revealed by the large unfavorable quantity variance and the almost equally large price variance. Management will most certainly look at the production process to find out why so much leather was required to make 250 footballs.

Potential causes of the Medina Co.'s unfavorable quantity variance are that the purchasing department bought an inferior, defective product that was more difficult to work with and therefore an excessive amount was spoiled in the production process. Or perhaps Medina has new workers who are not as experienced as they will be in the future. Or the company may have a very inefficient process that wastes too much leather.

A potential cause of the favorable price variance may go along with the potential cause of the unfavorable quantity variance—the inferior, defective leather purchased was less expensive.

In any case, despite the total cost variance being small, Medina needs to investigate further the cause of the individual quantity and price variances.

Direct Labor Variances

As with the materials variance, the **total labor variance** (also called the **flexible budget variance** for direct labor) is the difference between the actual labor costs incurred by the company for the period and the standard labor costs for the standard amount of direct labor **allowed** for the actual level of output at the standard wage rate per hour (the flexible budget). Similar to the total direct materials variance, the total direct labor variance is attributable to variances in both labor rates and labor usage, meaning that the company either paid a wage rate that was different from the standard rate, used a different number of labor hours than the standard number of hours allowed for the actual level of output, or both.

	Actual total direct labor costs incurred (money spent)	(AP x AQ)
–	**Standard amount of direct labor allowed for the actual output at the standard wage rate per hour**	(SP x SQ)
=	**Total direct labor variance**	

Because the direct labor variances are so similar to variance analysis for materials, direct labor variances will not be covered in detail. Briefly, the total labor variance can be broken down into the labor rate variance (a price variance) and the labor efficiency variance (a quantity variance). Direct labor price and quantity variances are calculated in the same manner as the direct material price and quantity variances; but, when direct labor is analyzed, different names are used for the price and quantity variances.

The Direct Labor Rate Variance (a Price Variance)

The direct labor rate variance is calculated in the same manner as the direct materials price variance:

(Actual Rate – Standard Rate) × Actual Hours

or

(AP – SP) × AQ = Labor Rate Variance

The above formula is actually a shorter way of expressing:

	Actual Rate × Actual Quantity
–	**Standard Rate × Actual Quantity**
=	**Labor Rate Variance**

The labor rate variance represents the difference between the cost of the actual labor used at the actual rate and the cost of the actual labor used if it had been paid at the standard rate.

The labor rate variance formula results in the portion of the total direct labor variance that was due to a difference between what was paid per hour (the actual rate) and the amount budgeted to be paid per hour (the standard rate) for direct labor actually used. Both the actual rate and the standard rate are multiplied by the actual quantity used to remove any effect of the quantity variance (called the efficiency variance) from the result.

Because the labor rate variance measures a cost variance, a positive result is an unfavorable variance because costs were higher than expected, while a negative result is a favorable variance because costs were lower than expected.

Causes of Direct Labor Rate Variances

Potential causes of an unfavorable direct labor rate variance include:

- A renegotiated union wage contract to pay higher wages, but the wage rate standard has not yet been adjusted to reflect the change in the wage rate;
- Inaccurate labor rate projections;
- Use of a single average standard wage rate that does not reflect the proportion of hours worked by each wage rate group of workers;
- Employees that had lower skill levels than planned were assigned to production.

Corrective actions depend on the identified cause. For example, if labor rate projections have been inaccurate or a single average standard wage rate has been used that does not reflect the proportion of hours worked by each group of workers, the standards may need to be adjusted.

A potential cause of a favorable direct labor rate variance is:

- The company has paid hourly wage rates that are lower than standard rates, which may mean employees are less qualified than management expected, leading to lower quality product, more defects, and higher warranty costs. Less qualified employees may also cause an unfavorable direct labor efficiency variance.

The Direct Labor Efficiency Variance (a Quantity Variance)

The direct labor efficiency variance is calculated the same manner as the direct materials quantity variance:

(Actual Hours − Standard Hours for Actual Output) × Standard Rate

or

(AQ − SQ) × SP = Direct Labor Efficiency Variance

The above formula is actually a shorter way of expressing the following:

	Actual Hours × Standard Rate
−	**Standard Hours × Standard Rate**
=	**Direct Labor Efficiency Variance**

The direct labor efficiency variance represents the difference in cost between the actual direct labor hours used if those hours had been paid at the standard hourly rate and the standard direct labor hours allowed for the level of actual output paid at the standard direct labor hourly rate.

The direct labor efficiency variance formula is used to calculate the portion of the total variance that was caused by either too much or too little direct labor having been used, without any reference to the amount of the variance that was caused by a difference between the actual rate and the standard rate per hour of the direct labor used. Both the actual hours and the standard hours allowed for the actual output are multiplied by the standard rate per hour to remove any effect of the labor rate variance from the result.

Because the labor efficiency variance measures a cost variance, a positive result is an unfavorable variance because costs were higher than expected, while a negative result is a favorable variance because costs were lower than expected.

Exam Tip: As with direct material variances, for the exam candidates need to be able to use the variance formulas to solve for the variance itself and also to solve for any of the individual variables in the formulas.

Causes of Direct Labor Efficiency Variances

Potential causes of an unfavorable direct labor efficiency variance include:

- Anything that negatively affects production workers' performance, such as inexperienced or inadequately trained employees;
- Anything that causes more time than the standard to be spent in production: Poor material quality, substitution of a component that is different from the standard, more equipment breakdowns than usual.

Potential causes of a favorable direct labor efficiency variance include:

- Performance of workers has exceeded the standard, possibly due to better training or more experience than expected;
- More highly skilled labor was used than was planned.

Note that use of more highly skilled labor may lead not only to a favorable direct labor efficiency variance but also to an unfavorable direct labor rate variance due to higher wages having been paid for the more highly skilled employees.

Fixed Overhead Variances

Fixed overhead costs are overhead costs that do not change in total as the level of production changes, as long as the production level remains within the relevant range. The best example of fixed overhead is factory rent, which cannot be traced to specific units manufactured and therefore is classified as an overhead cost. Because the rent payment is the same regardless of the factory's production level as long as the production level remains within the relevant range—which for rent is the maximum volume that can be produced on the premises—rent is a fixed cost.

Note: Fixed manufacturing overhead is unique. Even though fixed overhead does not change in total as the level of production changes, **fixed overhead is applied to production as if it were a variable cost that *does* change in total as the level of production changes**.

Because fixed overhead is applied to production as if it were a variable cost, but it is incurred and budgeted for as a fixed cost, fixed overhead variances are different from other types of variances. For direct materials, direct labor, and variable overhead, the amount of cost applied to production is the same as the flexible budget amount of cost allowed for the actual production. Therefore, the total direct materials, direct labor, and variable overhead variances are all their respective differences between actual cost incurred and the flexible budget/applied cost amount.

However, the amount of fixed overhead cost applied to production is **not** the same as the flexible budget amount of fixed overhead cost allowed for the actual production. The flexible budget amount of fixed overhead cost is the same as the static budget amount of fixed overhead cost because the total amount of budgeted fixed cost does not change with changes in production level as long as the activity remains within the relevant range. The total fixed overhead variance is the difference between actual fixed overhead incurred and the amount of fixed overhead applied to production, the same as the other total variances—but the amount of fixed overhead applied to production is not the flexible budget fixed overhead amount.

Therefore, the total fixed overhead variance is **not** the difference between actual fixed overhead incurred and the flexible budget fixed overhead amount. The difference between the actual fixed overhead incurred and the flexible budget fixed overhead amount is called the fixed overhead spending variance, and it is a sub-variance of the total fixed overhead variance.

The fixed overhead production-volume variance, another sub-variance of the total fixed overhead variance, records the difference between the flexible budget fixed overhead amount (which is the same as the static budget amount) and the amount of fixed overhead applied to production.

These two fixed overhead sub-variances will be described in more detail in the following discussion of fixed overhead variances.

Total Fixed Overhead Variance

Fixed overhead costs are allocated to units produced using the predetermined standard fixed overhead rate. Therefore, the total fixed overhead variance is the difference between the actual fixed overhead incurred and the amount that was applied using the standard rate and the standard usage of the application base for the actual level of output.

Actual fixed overhead incurred (money actually spent)
– **Standard fixed overhead *applied*** (standard rate × standard usage for actual output)*
= **Total fixed overhead variance**

*The "standard usage for actual output" in the formula is the **standard amount of the application base allowed for the actual output**.

The total fixed overhead variance is interpreted in the same way as other cost variances:

- A **positive** variance is an **unfavorable** variance because actual fixed costs were **greater than** the amount of fixed costs allowed for the actual output, and
- A **negative** variance is a **favorable** variance because actual fixed costs were **less than** the amount of fixed costs allowed for the actual output.

The total fixed overhead variance can be broken down into two sub-variances: the fixed overhead spending variance and the fixed overhead production-volume variance.

1) Fixed Overhead Spending (Flexible Budget) Variance

The fixed overhead spending variance, also called the fixed overhead flexible budget variance, is the difference between the actual fixed overhead costs incurred and the budgeted fixed overhead (flexible budget **or** static budget)[85] amount.

Actual fixed overhead incurred
– **Budgeted fixed overheads** (the flexible budget OR the static budget amount)
= **Fixed overhead spending/fixed overhead flexible budget variance**

The fixed overhead spending variance is the **actual amount** of fixed overhead incurred minus the **budgeted amount** of fixed overhead. The fixed overhead spending variance arises because actual fixed factory overhead incurred is different from (either greater than or less than) the amount budgeted for it.

[85] As long as production remains within the relevant range, budgeted fixed costs in the flexible budget will be the same as budgeted fixed costs in the static budget.

The interpretation of the fixed overhead spending/fixed overhead flexible budget variance is the same as for other cost variances:

- A **positive** variance is an **unfavorable** variance because actual costs were **greater than** budgeted costs, and
- A **negative** variance is a **favorable** variance because actual costs were **less than** budgeted costs.

Note: The first line of the fixed overhead spending variance formula is the same as the first line of the total fixed overhead variance formula.

Also, the flexible budget and the static budget amounts for fixed overhead are the same because fixed overhead is fixed and thus does not change with changes in production as long as production remains within the relevant range.

Causes of Fixed Overhead Spending Variances

Potential causes of an unfavorable fixed overhead spending variance include:

- New equipment purchased, resulting in increased depreciation expense (a fixed overhead cost);
- An increase in rent charged on manufacturing facilities;
- An increase in plant managers' salaries;
- An increase in insurance premiums on the manufacturing facilities.

Potential causes of a favorable fixed overhead spending variance include:

- A move to less expensive manufacturing facilities;
- A decrease in insurance premiums on the manufacturing facilities.

2) Fixed Overhead Production-Volume Variance

The fixed overhead production-volume variance is the difference between the budgeted amount of fixed overhead and the amount of fixed overhead applied (standard rate × **standard input for the actual level of output**). The fixed overhead production-volume variance is caused by a difference between the actual production level and the production level used to calculate the budgeted fixed overhead rate.

The fixed overhead production-volume variance has no connection to any actually incurred costs, so it is not a comparison between actual and budgeted costs in the way other variances are. Instead, it is a measure of capacity utilization.

The fixed overhead production-volume variance is calculated as follows:

  Budgeted fixed overheads (the flexible budget OR the static budget amount)
− **Standard fixed overhead *applied*** (standard rate × standard input for actual output)
= **Fixed overhead production-volume variance**

Note: The second line of the fixed overhead production-volume variance formula is the same as the second line of the total fixed overhead formula. Also, the **first** line of the fixed overhead production-volume variance formula is the same as the **second** line of the fixed overhead spending/flexible budget variance formula. The following diagram shows how the total fixed overhead variance is split into two variances.



The fixed overhead production-volume variance is the **budgeted amount** of fixed overhead minus the **amount of fixed overhead applied**. Interpretation of whether the fixed overhead production-volume variance is favorable or unfavorable is the same as for other cost variances:

- A **negative amount** (applied fixed overhead is greater than budgeted fixed overhead) is **Favorable** because it indicates that actual production has **exceeded** the budgeted production level.
- A **positive amount** (budgeted fixed overhead is greater than applied fixed overhead) is **Unfavorable** because it indicates that actual production has been **lower** than the budgeted production level.

Causes of Fixed Overhead Production-Volume Variances

The cause of an unfavorable fixed overhead production-volume variance is production having been lower than planned. Anything that has caused production to be lower than planned, such as equipment breakdowns or decreased customer demand that has caused production to be cut back, will cause an unfavorable fixed overhead production-volume variance.

The cause of a favorable fixed overhead production-volume variance is production having been higher than planned. Anything that has caused production to be higher than planned, such as increased customer demand that has caused production to be increased, will cause a favorable fixed overhead production-volume variance.

Note: There is no fixed overhead **efficiency** variance because fixed costs do not relate to levels of output and therefore cannot be used either efficiently or inefficiently.

Study Unit 35: D.4. Performance Measurement

Customer and Product Profitability Analysis

The ability to evaluate the profitability to the firm of a specific customer or group of customers is important because of the 80-20 rule: 80% of profits usually come from 20% of a firm's customers. Furthermore, 20% of a firm's customers are usually completely **unprofitable**. To maintain competitive advantage, a company needs to work hard to attract profitable customers and keep them, and it needs to work equally hard to discourage the unprofitable customers from continuing to drag down profits. Profitable customers can be attracted and kept through outstanding customer service and unprofitable customers can be discouraged with fewer discounts and promotional offers.

Customer profitability analysis determines the profitability of an individual customer or a group of customers, enabling managers to coordinate their customers' costs-to-serve. A manager might want to re-price activities that cause high costs-to-serve or reduce available services for customers that are high cost-to-serve. To customers that are identified as low cost-to-serve, the manager can offer discounts to increase the sales volume from that group of customers. The most profitable customers can be provided with improved customer service to maintain their loyalty.

If a particular customer is unprofitable because of the mix of products or services the customer is purchasing or using, the manager may be able to shift that customer's mix toward higher-margin products and services, thereby converting an unprofitable customer into a profitable customer.

Customer profitability information can also be used for targeted marketing. It can reveal the types of customers the company wants to market to and the types it does not want to market to.

An example of customer profitability information is a bank generating data about the services being used by each business customer. Many banks use account analysis to determine the total fees to charge their business customers. At the end of each month or each quarter, the bank prepares an analysis report for each business customer showing the customer's average balance of loans outstanding, the interest rate being charged on the loans, and the bank's cost for the funds lent out to that customer. A large commercial customer might use cash management services such as lockbox or concentration banking, and providing those services generates costs for the bank, such as an allocated portion of the cash management operations employees' salaries and facility costs. The non-interest-bearing checking account deposits the commercial customer keeps in the bank are available to the bank to invest in loans to other customers, thereby generating revenue. The bank inputs each customer's information on all services used into an account analysis for the customer each period, and the analysis process generates the fee the customer owes for the period, decreased by a credit for average non-interest-bearing funds kept on deposit. The bank sends the account analysis report to the customer along with its fee invoice, and if a customer wants to decrease future fees, he or she can make changes such as increasing the amount of non-interest-bearing funds kept on deposit with the bank.

Product profitability analysis is just as important as customer profitability analysis. Product profitability analysis can identify products and services that are unprofitable so that those products and services can be either re-priced or discontinued and replaced with new products and services that are more profitable.

When customers and products are being evaluated for their profitability, accurate allocations of common costs and shared services are critical.

Performance Measurement

The financial success of a segment and the performance of its manager can be measured in many ways. Return on Investment (ROI) and Residual Income (RI) are the primary means of segment financial measurement that candidates should know. Candidates should know what each one is, how each is calculated, how each one is interpreted, and how they compare and contrast with each other.

Each of these methods by itself measures only one thing, and therefore one method by itself does not provide a complete evaluation of a manager or a department.

Return on Investment (ROI)

Return on Investment (ROI) can be used to evaluate the performance of the entire firm, but it can also be used to evaluate the performance of single divisions and their division managers.

ROI is the key performance measure for an investment center. It measures the percentage of return that was earned on the amount of the investment (that is, assets). The formula for ROI is:

$$\textbf{ROI} = \frac{\textbf{Income of Business Unit}}{\textbf{Assets of Business Unit}}$$

Interpreting ROI

ROI can be used as an evaluation tool to evaluate a segment's performance in comparison with the performance of other segments and with the overall company, or as a decision tool, as part of the determination of whether the projected return from a project under consideration will be adequate.

If ROI is used as an evaluation tool, management must be certain that it is the correct measurement for the company's goals and that the ROI goals are representative of that individual segment's market and business.

A manager can also use ROI in determining if the division should accept a capital investment or project. Capital investment decisions involve more than just calculating the ROI of a project, but a project's ROI can contribute to the decision. A proposed capital investment project's ROI can be compared with the company's required rate of return as part of the decision process. If the ROI of the project is higher than the target or required rate of return or hurdle rate, the project is acceptable. Conversely, if the ROI is lower than the required rate of return, the project is not acceptable. A division manager will probably reject the project, even if the project itself is projected to be profitable.

The **required rate of return**, also called the **hurdle rate**, is the minimum rate of return that a segment or project must earn to justify the investment of resources. **Senior management of the company determines what the company's required rate of return should be**. Generally, a company's weighted average cost of capital, or WACC, is its minimum required rate of return. However, the required rate of return set by management may be higher than the firm's weighted average cost of capital, depending on the risk inherent in the segment or project. If the level of business risk for a particular segment or project is judged to be higher than the overall firm's level of business risk, the required rate of return for that segment or project will be increased above the firm's weighted average cost of capital.

Residual Income (RI)

Residual Income (RI) attempts to overcome the weakness in ROI by measuring the **amount of monetary return** that is provided to the company by a department or division. RI for a division is calculated as the amount of return (**operating income before taxes**) that is in excess of a **targeted amount of return** on the division's assets. Residual income is the operating income earned after the division has covered the required charge for the funds that have been invested by the company in its operations.

When evaluating a potential project for investment, any project that has a positive RI will be accepted, even if it will reduce the overall company's or unit's ROI.

Note: If the expected rate of return on a new investment is greater than the required rate of return (usually the cost of capital), residual income will increase due to the new investment, even if the expected return on investment (ROI) for the new project is lower than the current return on investment. An investment that may have been rejected on the basis that its ROI was lower than the unit's existing ROI would instead be accepted, and the company would benefit from the new investment.

The following items are very important to know in regard to the calculation of RI.

1) The **targeted amount of return** is usually an annual percentage of, or annual rate of return on, the total employed assets of the division, or the **invested capital** in the division, and

2) The **percentage used** in the calculation is the **required rate of return that management has set**.

The required rate of return may be the company's weighted average cost of capital, or it may not be. The required rate of return is whatever rate management sets. **Management sets the required rate of return**.

If the required rate of return is not given in a question but the company's weighted average cost of capital is given, use the company's weighted average cost of capital as the required rate of return.

The **formula for RI** is:

Operating income of business unit
– (Assets of business unit × required rate of return)
= Residual Income

Assets of the business unit multiplied by the required rate of return is the business unit's **target return**. Thus, Residual Income is the business unit's actual operating income minus its target operating income (target return).

Note: In the calculation of Residual Income, the target return (assets of the business unit × required rate of return) is an **imputed cost** of the investment. This imputed cost is the **opportunity cost** of other potential returns that have been forgone in making the investment in the business unit's assets. The required rate of return is determined by senior management. It **might** be equal to the firm's weighted average cost of capital or the marginal cost of capital for a given project, but it is the required rate of return because it is the rate management has selected as the required rate.

Example: Medina Division of Erie Company has total assets of $4,000,000 and operating income of $600,000. Its required rate of return is 10%. How much residual income does Medina Division have?

The target return = $4,000,000 × 0.10 = $400,000

Operating income of $600,000 less $400,000 target return = $200,000 of residual income.

Note: **Residual Income may be a negative amount**. Negative Residual Income occurs when the profits that the division or project actually achieved are less than the target income that was set for the division or project.

Study Unit 36: D.5. Cost Information for Decision Making

Cost-volume-profit analysis (CVP), also known as **breakeven analysis**, is used primarily for short-run decision-making. In the short run, the markets usually determine the prices and costs of a company's products. The markets govern prices, chiefly by what consumers are willing to pay and the actions of competitors. Furthermore, costs can be reduced to a certain degree by seeking cost concessions from suppliers and by **value engineering**.[86] Otherwise, the only things the company can control are the products it makes and the quantities it produces and sells—in other words, the supply of the product.

Companies use CVP analysis to determine which products they will supply and the amount they will supply at a given price and cost. Since prices and costs are reasonably fixed in the short run, the profitability of a product depends most on the quantity sold. Therefore, CVP analysis is used to calculate the effect on profitability caused by changes in product mix and in quantities sold.

CVP analysis enables a company to find the level of production and sales, both in units and in revenue, required for the company to break even. It may also be used to determine the level of production and sales necessary to achieve a specific profit level. In short, CVP analysis examines **the relationship among revenue, costs, and profits**.

To use CVP analysis, several assumptions need to be made. These assumptions simplify the many variables in the real world:

- **All costs are either variable or fixed costs**. The presumption is that there are no mixed (that is, semi-variable or semi-fixed[87]) costs.
- **Total costs and total revenues are predictable and linear** (they graph as a straight line) in relation to output units within the relevant range[88] for a particular period.
- Changes in the level of total revenues and total costs arise only because of **changes in the number of units produced and sold**.
- **Fixed costs remain constant** over the relevant range. Fixed costs include both direct fixed costs and indirect (allocated) fixed costs.
- **Unit variable costs remain constant over the relevant range.** Total variable costs change in proportion to activity level while the cost per unit remains constant. Variable costs include both direct variable costs and indirect (allocated) variable costs.
- **The unit selling price remains constant over the relevant range**, and the sales mix remains constant as the level of total units sold changes.

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[86] "Value engineering" is an evaluation of all the business functions in the value chain with the objective of reducing costs while still satisfying customer needs. The term "value chain" refers to the steps a business goes through to transform inputs such as raw materials into finished products by adding value to the inputs by means of various processes, and to finally sell the finished products to customers. Value engineering may lead to design improvements, materials specification changes, or modifications to manufacturing methods.

[87] A semi-variable cost has both a fixed component and a variable component. A basic, fixed amount must be paid, regardless of activity and even if there is no activity. Added to that fixed amount is an amount that varies with activity.

A semi-fixed cost, also called a step cost or a step variable cost, is fixed over a given, small range of activity, and above that level of activity the cost suddenly jumps. It stays fixed at the higher range of activity; however, when the activity moves out of the higher range, it will jump again. A semi-fixed cost moves upward in a step fashion, staying at a certain level over a small range and then moving to the next level quickly. All fixed costs behave this way, and a wholly fixed cost is also fixed only while activity remains within the relevant range. However, a semi-fixed cost is fixed over a smaller range than the relevant range of a wholly fixed cost.

[88] The "relevant range" for an activity is a level between a designated minimum and maximum. Within the designated range, a specific related amount of revenue or cost can be expected. "Relevant range" is particularly pertinent when referring to fixed costs, because a fixed cost is expected to remain fixed only when the related activity level remains within the relevant range. Outside of that range, the cost is expected to be different.

- When a company sells two or more products, a **constant sales mix** is assumed. If the sales mix changes, the quantity of each product that will need to be sold to break even will also change.
- The **time value of money is ignored**.

In the real world, the preceding assumptions may not hold. For example, as the quantity of direct materials purchased increases, the supplier may offer a lower price per unit; or to increase sales, the company may need to reduce its selling price per unit. Variations such as these would complicate the analysis, so they are excluded.

Contribution Margin

Contribution margin is an important concept in CVP analysis. The contribution margin represents the amount of revenues minus variable costs available to cover fixed costs. Once the fixed costs have been covered, further increases in the contribution margin from increased sales volume flow straight to operating income.

CVP analysis assumes that two (and only two) kinds of costs are involved in producing a product: fixed costs and variable costs.

- **Fixed costs** do not change in total. While the activity remains within the relevant range, the level of production or sales has no effect on fixed costs in total, but the per-unit fixed costs increase or decrease with changes in activity.
  - An increase in activity beyond the upper limit of the relevant range might require additional fixed costs for facilities or supervisory and administrative personnel, increasing fixed costs in total.
  - A decrease in activity beyond the lower limit of the relevant range requires management decisions as to the best use of unused fixed assets or the best way to adjust other fixed costs.
- **Variable costs** are variable manufacturing costs or variable selling and administrative costs. Variable manufacturing costs are costs per unit **produced**. Variable selling and administrative costs are costs per unit **sold**. Variable costs change **in total** in response to fluctuations in the level of activity, either production or sales.

Costs are classified as variable or fixed based on the relevant range for a specific activity and for a specific period such as a month.

Example: Fixed production costs are fixed over a relevant range of 10,000 to 20,000 units per month. The maximum production possible with the existing facilities and supervisory and support personnel is 20,000 units per month, but if production volume of 25,000 units per month is needed because of an increase in demand, additional facilities and personnel will be needed. If demand falls below 10,000 units per month and remains there, it will be necessary to shut down production lines.

However, the higher or lower demand levels need to persist for some time before management can conclude that changes to facilities and other fixed costs are appropriate. Furthermore, if management determines that the increase or decrease will be long-term and changes are needed, the changes will require time to plan and implement. Over a long enough period, though, changes can be made in fixed costs. **Therefore, over the long term, all costs are variable costs.**

On a per-unit basis, the difference between an item's selling price and the variable costs to produce and sell it goes toward covering a company's fixed costs. The difference between the selling price of a unit and its variable cost is the **unit contribution margin** (or sometimes simply **contribution**) and is calculated as follows:

Unit Contribution Margin = Selling Price per Unit – Variable Costs per Unit

The total contribution margin can be calculated in two ways:

1) Total Contribution Margin = Unit Contribution Margin × Number of Units Sold

Or

2) Total Contribution Margin = Total Revenue – Total Variable Costs

Example: Ray Company manufactures wireless routers and sells them to distributors for $60 each. Ray Company's variable cost is $35 per router. The **unit contribution margin** is:

$60 – $35 = $25

If Ray Company sells 10,000 wireless routers, total revenue will be 10,000 × $60, or $600,000. Total variable cost will be 10,000 × $35, or $350,000. The **total contribution margin** is:

$25 × 10,000 = $250,000

Or

$600,000 – $350,000 = $250,000

Contribution Margin Income Statement

Under CVP analysis, the income statement shows variable costs deducted from revenue, which then produces a key line item that does not appear on the standard income statement, **contribution margin**, and fixed costs are expensed below the contribution margin line, as follows:

	Sales revenue
–	Variable costs
=	**Contribution margin**
–	Fixed costs
=	**Operating Income**

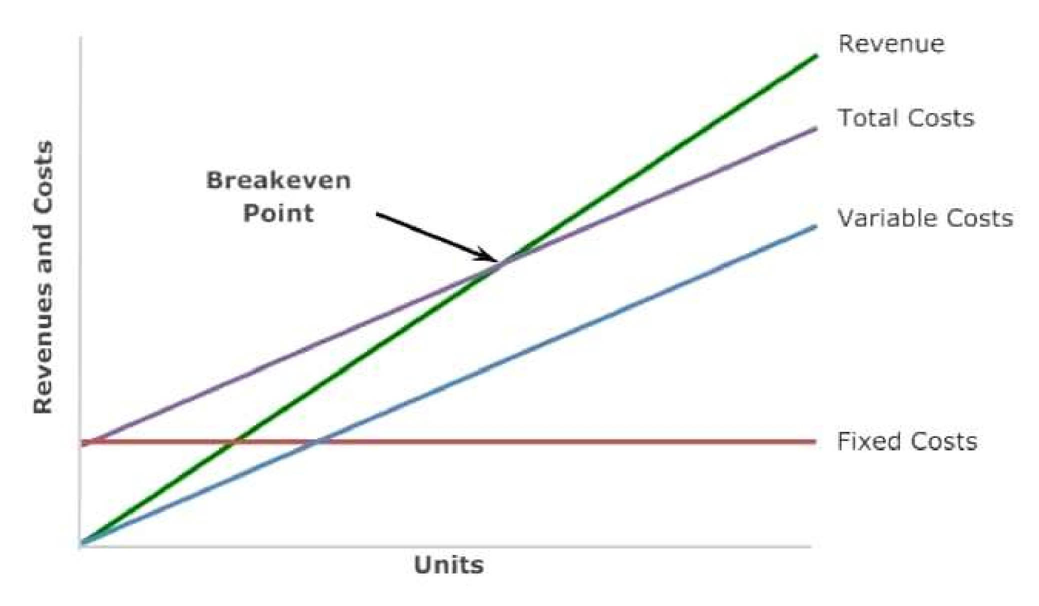
Exam Tip: The preceding formula can be used to check an answer on the exam. At the breakeven point number of units, the operating income will be $0.

Example: Carl Company sells its product for $100 per unit. Fixed costs are $120,000 and the variable cost is $60 per unit. The unit contribution margin is $40 per unit ($100 – $60), which is the contribution to the coverage of fixed costs made by the sale of each unit. The following chart shows how the contribution margin increases as sales volume increases, more of the fixed costs are covered, and operating income changes from negative to positive:

Sales Volume:	1,000	2,000	3,000	4,000	5,000
Revenues @ $100	$ 100,000	$ 200,000	$ 300,000	$ 400,000	$ 500,000
Variable Costs @ $60	60,000	120,000	180,000	240,000	300,000
Contribution Margin	$ 40,000	$ 80,000	$ 120,000	$ 160,000	$ 200,000
Fixed Costs	120,000	120,000	120,000	120,000	120,000
Operating Income	$(80,000)	$(40,000)	$ 0	$ 40,000	$ 80,000

Breakeven Analysis

Managers need to know the level of sales necessary to cover all costs, both fixed and variable, to avoid a loss. Following is a graphic representation of the breakeven point.



The breakeven point can be calculated in terms of the **sales volume** (**number of units sold**) required to break even, or it can be calculated in terms of the amount of **revenue** required to break even.

Breakeven Sales Volume (Breakeven Point in Units)

To calculate the breakeven **volume**, divide the fixed costs by the contribution margin per unit:

$$\textbf{Breakeven Volume (units)} = \frac{\textbf{Total Fixed Costs}}{\textbf{Unit Contribution Margin}}$$

In other words, each unit that is sold contributes to the coverage of fixed costs. Dividing total fixed costs by the contribution per unit produces the number of units that must be sold to cover the fixed costs and therefore break even.

Example: Ray Company manufactures wireless routers and sells them to distributors for $60 each. Ray Company's variable cost is $35 per router.

Ray's unit contribution margin is:

$60 − $35 = $25

Ray Company's fixed costs total $150,000. Ray's breakeven volume is:

$$\text{Breakeven volume} = \frac{\$150{,}000}{\$25} = \underline{\textbf{6,000}}\textbf{ units}$$

The calculated breakeven volume can be proven through use of the standard profit formula, which is

Profit	=	Total Revenue	−	Total Variable Costs	−	Total Fixed Costs:		
Profit	=	(6,000 × $60)	−	(6,000 × $35)	−	$150,000		
	=	$360,000	−	$210,000	−	$150,000	=	**<u>$0</u>**

The Importance of Marginal Analysis

Marginal analysis examines how benefits and costs respond to incremental changes in production. Any incremental change (for example, the production of one more unit) results in additional benefits, but it also incurs additional costs. According to economic theory, rational persons "think at the margin"; that is, in making any decision, a person will undertake an action only if the expected additional (or marginal) benefit exceeds the additional (or marginal) cost of doing so. Marginal analysis is used to determine whether the expected added benefit of an action is greater than the expected added cost of the action.

Example: The following illustrates the factors involved in marginal analysis.

A clothing buyer is purchasing clothing for the new season. A wholesaler offers a 10% discount for purchases over $100,000 and a 14% discount for purchases over $200,000. After the buyer selects the items she desires, the total price comes to $190,000 and qualifies for the 10% discount ($19,000), making the net cost $171,000.

However, with an additional $10,000 worth of items, the base cost of the order would increase to $200,000 and would qualify the purchase for the 14% discount. With $28,000 off the $200,000 price, the net cost for all the items would be $172,000, only $1,000 more.

The **marginal cost** of that additional $10,000 in items added to the order would be only $1,000, 90% less than the value of the additional items. The added benefit of purchasing the additional items ($10,000) is greater than the added cost ($1,000) of those additional items.

Marginal Revenue and Marginal Cost

The terms "marginal revenue" and "marginal cost" when applied to production or other activities refer to the addition to total revenue and the addition to total cost that result from a one-unit increase in the activity.

- The **marginal revenue** resulting from an increase in activity is the **incremental revenue** from the increased activity, for example sale of the additional production. The incremental revenue is total revenue after the activity increase minus total revenue before the activity increase.
- The **marginal cost** resulting from an increase in activity such as increased production is the **incremental cost** that is incurred for the increased activity. The incremental cost is total cost after the activity increase minus total cost before the activity increase.

"Marginal revenue" and "marginal cost" can also refer to the addition to total revenue and the addition to total cost, respectively, that would result from a project that is under consideration.

Relevant Information Versus Not Relevant Information

One of the primary challenges in the decision-making process is distinguishing between factors that are **relevant** to the decision and factors that are **not relevant** to the decision. In general, the following two considerations can help to identify which factors are relevant:

- **Factors that focus on the future are relevant**. Events or costs incurred in the past (that is, **sunk costs**) cannot be changed, and therefore are **not relevant**.
- **Factors that differ among possible alternatives are relevant**. Revenues and costs that are the same for all the options under consideration are **not relevant** because they will be the same no matter which option is selected.

Relevant Revenues and Relevant Costs

Relevant revenues are revenues that are future and differ between or among alternatives. Relevant costs are costs that are future and that differ between or among alternatives.

For example, when a decision is being made about whether to invest in a new project, the forecasted additional revenues the project would generate are relevant revenues and the forecasted additional costs of the project are relevant costs.

Note: Revenues and costs are relevant if:

1) They occur in the future, **and**

2) They differ between or among the various alternatives available.

Sunk Costs

A sunk cost is a cost for which the money has already been spent and cannot be recovered. Sunk costs are **not relevant** to decision-making because they are past costs—not future costs—and they cannot be changed regardless of any decisions made for the future.

Differential and Incremental Revenues and Costs

Relevant revenues and costs are also classified as "differential revenues" and "differential costs" or "incremental revenues" and "incremental costs." The terms "differential" and "incremental" are often used interchangeably; however, they are not the same.

- Differential revenues and costs are those that **differ between two alternatives**.
- Incremental revenues are those that are **received additionally** because of an activity, and incremental costs are those that are **incurred additionally** because of an activity.

Example: The following illustrates the factors involved in differential and incremental costs.

A company's machine has worn out, cannot be repaired, and must be replaced (that is, keeping it is not an option). Management has two choices: it can either replace the worn-out machine with an updated model of the same type or it can upgrade to a fully automated, totally different system. The difference in costs between the replacement machine and the upgraded machine is the **differential cost**. (The cost of doing nothing is not relevant because it is not an option.)

On the other hand, if the machine had not yet worn out, then the choice would be between keeping it at its existing cost or upgrading to a new machine. The relevant cost is the difference between the current cost for the old machine and the cost for the upgraded machine. The additional cost of the upgraded machine, over and above the current cost for the existing machine, represents **incremental cost**. It is the cost the company would incur by upgrading that is **in addition** to the present cost of keeping the old machine.

Avoidable and Unavoidable Costs

Avoidable and unavoidable costs are another classification of relevant and irrelevant costs used in decision making.

- An **avoidable cost** is an existing cost that can be avoided because the cost will go away if a particular option is selected. Avoidable costs are **relevant** to the decision-making process because they will continue if one course of action is taken but they will not continue (that is, will be avoidable) if a different course of action is taken.
- An **unavoidable cost** is an expenditure that cannot be avoided and will not go away, regardless of which course of action is taken. Unavoidable costs are **not relevant** to the decision at hand because they do not differ between alternatives.

Example 1: A decision to outsource or not to outsource.

A company is considering outsourcing its production. If production is outsourced, the variable cost to produce the product in-house will go away and be replaced by the cost to purchase the product externally. In addition, a portion of the company's fixed manufacturing costs will go away. These in-house variable costs and the fixed costs that would go away if the production were outsourced are **avoidable costs**. Those avoidable costs are **relevant costs** to the decision-making process because such costs will continue if one course of action is taken (production is maintained in-house) but they will not continue if another course of action is taken (production is outsourced). The cost to purchase the product manufactured externally that will replace the avoidable costs is another **relevant cost** to be considered.

However, this decision also includes **unavoidable costs**. For example, the company has non-cancelable leases for in-house equipment. Even if production is outsourced and the machines are no longer being used, the company is still obligated to continue making the lease payments. Unlike avoidable costs, **unavoidable costs are not relevant** to the decision-making process because they will be the same regardless of which decision is made.

Example 2: A decision to close a plant.

Avoidable and unavoidable costs are important to a decision to close a plant or other business unit. If closing the unit would avoid certain costs, those **avoidable costs** are **relevant** to the decision. **Unavoidable costs**, however, are **irrelevant** because they do not differ between the two alternatives. If some of the fixed plant costs would continue even if the plant were closed, those costs are unavoidable and not relevant to the decision.

A central administrative cost that has been allocated to a division is another example of an unavoidable cost that would continue if the division were closed. Even if that division were to be closed, the cost would continue to be incurred by central administration. It would simply be allocated to another division or divisions. So, the central administrative cost borne by the whole company would not differ between the two alternatives of closing the division or keeping it open.

Only costs that would be avoided (costs that would go away) if the division were closed are relevant to the decision to close a division or not to close it.

Economic Versus Accounting Concepts of Costs and Opportunity Costs

From an accounting perspective, only explicit costs (accounting costs) are considered. An **explicit cost** is a cost that can be identified and accounted for. Explicit costs represent obvious cash outflows from a business.

For the economists, not only the typical costs such as monetary expenditures are part of all the costs that a company or an individual incur, but the potential earnings from a **forgone alternative** that had to be dismissed to achieve a particular goal are also considered. For example, in making a deal, a businessperson needs to devote time to negotiations and preparing the contracts, and that is forgone time that cannot be used for another deal. Hence, the potential earnings from this lost time are part of the costs that should be considered. Similarly, a truck that is loaded with aluminum cannot simultaneously (at the same time) transport iron. The contribution to profits the trucking company is giving up if it chooses to transport aluminum instead of iron is a cost of transporting the aluminum.

The potential earnings from the forgone alternative are called an **opportunity cost** of the chosen option. The concept of opportunity cost is one of the major distinguishing features between the way accountants evaluate situations and the way economists evaluate them.

An opportunity cost is the benefit that could have been gained from an alternative use of the same resource. It is the contribution to income that is lost when a limited resource is not used in its best alternative use. Opportunity cost is calculated only from the revenues that would **not be received** and expenditures that would **not be made** for the other available alternative.

An opportunity cost is a type of **implicit cost**, also called an **imputed cost**. The word "implicit" comes from the root word "implied." An implicit (or imputed) cost is an implied cost that does not appear in the income statement, but it affects the company's net income just as if it were in the income statement. An implicit cost is more difficult to identify than an explicit cost because it does not clearly show up in the accounting records. An opportunity cost is an economic cost and an implicit cost but not an accounting cost.

Accountants ignore opportunity costs because opportunity costs are hard to calculate due to a lack of precise numbers and costs. However, opportunity costs guide decisions on how to allocate resources in the most efficient way. Opportunity costs highlight the forgone earnings that could have resulted from the best alternative use of the resources, creating a bigger picture of the total effort that must be undertaken to achieve an objective.

Opportunity Costs are Relevant Costs

Both explicit and implicit costs must be used in making decisions. Therefore, relevant costs may include opportunity costs. Opportunity costs can and should be estimated in any decision where they are a factor. For instance, in a make-or-buy decision, if the facilities being used to make one product could be used in the production of an alternative item, the contribution to income from the alternative item (the item that would be foregone to continue to use the facilities to make the current item) is an opportunity cost of continuing to manufacture the current product in-house.

Opportunity costs are relevant in decision making because opportunity costs are in the future and differ between alternatives just as surely as accounting costs do.

Example 1: A company manufactures Item A; however, the company could have used the same facilities to produce Item B. The **opportunity cost** of producing Item A is the contribution to income that Item B would have provided if the company had manufactured Item B instead.

Example 2: A company takes $50,000 out of its invested funds and uses it to buy some new equipment to manufacture a new product. The company is giving up the investment income it could have earned on that $50,000 if it had left the funds invested. That loss of income needs to be considered against the net cash flow the company expects to earn from the manufacture and sale of the new product. The lost investment income on the $50,000 is an **opportunity cost** of manufacturing the new product, and it should be included in any incremental analysis used to decide whether to buy the new equipment.

Opportunity cost is calculated only from the **revenues that would not be received and expenditures that would not be made** for the other available alternative(s). Similarly, any interest cost that is part of the opportunity cost can be calculated only for the period when the cash flows are **different** between or among the options.

Note: **Opportunity costs exist only when the availability of a resource is limited or constrained**. If resources are not constrained, no opportunity cost can exist because all available opportunities are options that can be selected, and no opportunities need to be forgone.

For example, if a company has unused production capacity, it can accept a new order without having to stop producing other orders. However, if the company is already producing at capacity, accepting a new order would mean stopping the production of some existing orders. Although the company would earn a contribution margin by producing the new order, it would need to give up the contribution margin from the orders that it could not produce during the same period. The surrendered contribution margin is an opportunity cost that should be included in the calculation of the cost of the new order when deciding whether to accept it.

